CHAPTER II - RECONNAISSANCE & COMMUNICATIONS

1. GENERAL

The Joint Typhoon Warning Center relies primarily on two reconnaissance platforms to provide the required fix data for tropical cyclone warnings. In 1975 these two platforms, namely aircraft and satellite, provided 85.9 percent of the fixes used for tropical cyclone warnings in the western North Pacific with land radar, synoptic data, and extrapolation forming the basis of the remaining 14.1 percent. In addition, another 196 satellite fixes were made in the Indian Ocean. Timely satellite coverage was hampered this year with the loss of local readout capabilities and eventual total loss of an afternoon and an early morning satellite over the western North Pacific.

2. RECONNAISSANCE RESPONSIBILITY AND SCHEDULING

Aircraft weather reconnaissance is performed in the JTWC area of responsibility by the 54th Weather Reconnaissance Squadron (54WRS). The squadron, presently equipped with WC-130 aircraft, is located at Andersen Air Force Base, Guam. The JTWC reconnaissance requirements are sent daily during the typhoon season to the Tropical Cyclone Aircraft Reconnaissance Coordinator (TCARC). These requirements include areas to be investigated, fix times and forecast position of cyclones to be fixed, and synoptic tracks to be flown. IAW CINCPACINST 3140.1M, "Usage of reconnaissance assets in acquiring meteorological data from aircraft, satellite, and landbased radar shall be at the discretion of FLEWEACEN/JTWC, Guam based on the following priorities: (1) Alert flights and vortex or center fixes as required for issuance of tropical cyclone warnings in the Pacific area of responsibility; (2) Center or vortex fixes as required for issuance of tropical cyclone warnings in the Indian Ocean area of responsibility. Vortex fixes will not be levied until maximum sustained winds are estimated to exceed 33 kt and the location and forecast movement imply a threat to DOD interests; (3) Supplementary fixes; and (4) Synoptic data acquisition".

As in previous years, aircraft reconnaissance provided direct measurements of height, temperature, flight level winds, sea level pressure, and numerous other parameters. These data are vital to the forecaster for indications of changing cyclone characteristics, thus providing a broader basis for tropical cyclone warnings. Another important aspect of this data is its availability for research in tropical cyclone analysis and forecasting.

DMSP satellites provide day and night coverage of the JTWC area of responsibility. Interpretation of this satellite imagery provides cyclone positions and for daytime passes, provides estimates of intensities using the DVORAK technique (NOAA TECHNICAL MEMORANDUM, NESS-45 and FIRST WEATHER WING PAMPHLET 105-10). This year the readout was only available at JTWC in a timely manner for the 0000Z and 1200Z warnings. However, Air Force Global Weather Central, Offutt AFB provided position data from an afternoon satellite for much of the season until this satellite lost its capability to transmit. As in 1974 satellite coverage of the western North Pacific proved extremely useful in identifying areas of possible tropical cyclone formation, thus reducing the number of aircraft investigative flights on systems that did not later become tropical cyclones.

Land radar provides useful positioning data on well developed cyclones when in the proximity (usually within 200 nm of radar position) of the Republic of the Philippines, Hong Kong, Taiwan, Japan (including the Ryukus), and Guam.

3. AIRCRAFT RECONNAISSANCE EVALUATION CRITERIA

The following criteria are used to evaluate reconnaissance support to JTWC.

a. Six-hour fixes- To be counted as made on time, a fix must satisfy the following criteria:

(1) Fix must be made not earlier than 1 hr before, nor later than 1/2 hr after scheduled fix time.

(2) Aircraft in area requested by scheduled fix time, but unable to locate center due to:

(a) Cyclone dissipation; or

(b) Rapid acceleration of the cyclone away from the forecast position.

(3) If penetration not possible due to geographic or other flight restrictions, aircraft radar fixes are acceptable.

b. Levied 6-hr fixes made outside the above limits are evaluated as follows:

(1) Early-fix is made within the interval from 3 hr to 1 hr prior to scheduled fix times. However, no credit will be given for early fixes made within 3 hr of the previous fix.

(2) Late-fix is made within the interval from 1/2 hr to 3 hr after scheduled fix time.

c. When 3 hr fixes are levied, they must satisfy the same time criteria discussed above in order to be classified as made on time. Three-hour fixes made that do not meet the above criteria are classified as follows:

(1) Early-fix is made within the interval from 1 1/2 hr to 1 hr prior to scheduled fix time.

(2) Late-fix is made within the

interval from 1/2 hr to 1 1/2 hr after scheduled fix time.

d. Fixes not meeting the above criteria are scored as missed.

e. Levied fix time on an "as soon as possible" fix is considered to be:

(1) Sixteen hour plus estimated time enroute after an alert aircraft and crew are levied; or

(2) Four hours plus estimated time enroute after the DTG of message levying an ASAP fix if an aircraft and crew, previously alerted, are available for duty.

f. Investigatives-to be counted as made on time, investigatives must satisfy the following criteria:

(1) The aircraft must be within 250 nm of the specified point by the scheduled time.

(2) The specified flight level and track must be flown.

(3) Reconnaissance observations are required every half-hour in accordance with AWSM 105-1. Turn and mid-point winds shall be reported on each full observation within 250 nm of the levied point.

(4) Observations are required in all quadrants unless a concentrated investigation in one or more quadrants has been specified.

(5) Aircraft must contact JTWC before leaving area of concern.

g. Investigatives not meeting the time criteria of paragraph f, will be classified as follows:

(1) Late-aircraft is within 250 nm of the specified point after the scheduled time, but prior to the scheduled time plus 2 hr.

(2) Missed-aircraft fails to be within 250 nm of the specified point by the scheduled time plus 2 hr.

4. AIRCRAFT RECONNAISSANCE SUMMARY

During the 1975 tropical cyclone season 212 six hourly vortex fixes and 5 supplementary vortex fixes were levied (Table 2-1). This is a significant decrease from 1974 and is the lowest number of aircraft levies since the 1965 season. This is due primarily to the low level of storm activity observed in 1975, which was 30% below the long-term average. Continuing heavy reliance on DMSP data is an important contributing factor to this decrease in aircraft levies. In addition to vortex fixes, 21 investigative flights were levied by JTWC in 1975. Approximately 49% of all warnings were based on aircraft fixes, 36% on satellite data and the remaining 15% based on radar, synoptic data or extrapolated positions.

Reconnaissance effectiveness is summarized in Table 2-1. The missed fix rate of 3.2% is a considerable improvement over 1974.

TABLE 2-1. AIRCRAFT RECONNAISSANCE EFFECTIVENESS

	NUMBER OF FIXES	PERCENT
COMPLETED ON TIME	200	92.2
EARLY	1	0.5
LATE	9	4.1
MISSED	7	3.2
TOTAL	217	100.0

LEVIED VS. MISSED FIXES

	LEVIED	MISSED	PERCENT
AVERAGE 1965-1970	507	10	2.0
1971	802	61	7.6
1972	624	126	20.2
1973	227	13	5.7
1974	358	30	8.4
1975	217	7	3.2

5. SATELLITE RECONNAISSANCE SUMMARY

Satellite reconnaissance of tropical cyclones is performed by the Air Weather Service, using Defense Meteorological Satellite Program (DMSP) Data. A unique network of tactical DMSP readout sites throughout the Pacific (at Nimitz Hill, Guam; Kadena AB, Japan; Yokota AB, Japan; Hickam AFB, Hawaii; and at Clark AB, Philippines, which relocated from Nakon Phanom, Thailand in September 1975) and Air Force Global Weather Central (AFGWC) at Offutt AFB, Nebraska, daily monitor the western North Pacific and Indian Oceans for tropical cyclone activity. When a tropical cyclone matures and is in warning status, this network provides JTWC with positions and intensity estimates (ref. NOAA TM 45). During 1975, 99% reliability in satisfying JTWC warning requirements was achieved by utilizing the dual-site coverage philosophy which insures that two sites are providing inputs for each fix.

Several important developments occurred in 1975. Typhoon Winnie, Tropical Storms Susan and Doris, and Tropical Depressions 05, 24 and 25 were monitored without the use of aircraft reconnaissance. Winnie was the first WESTPAC typhoon to be handled in this manner. At CINCPAC's direction JTWC's Indian Ocean area of responsibility was expanded westward from longitude 80°E to 62°E. As a result, the DMSP network became involved in monitoring a significantly larger portion of the tropical oceans, and AFGWC's role of providing tropical cyclone positions and intensity estimates to JTWC was expanded.

Satellite positions are assigned Position Code Numbers (PCN's), depending on the procedures used to make the position, and the state of the cyclone's circulation. These are shown in Table 2-2.

A comparison of DMSP derived positions and JTWC Best Tracks is shown in Table 2-3.

Table 2-3 is important because it demonstrates that the PCN groupings are statistically stable from year to year, and represent an operationally reproducible system for storm fix classification. It shows that the DMSP analyst can accurately identify the organization of tropical cyclones by cloud signatures, that positioning accuracies are improved by using geographical references to correct the gridding, and that the better a tropical cyclone is organized the more accurately it can be positioned by satellite data. Note that geographical checks on gridding are of particular significance if the eye of the storm is apparent. The small improvement in positioning accuracy in 1975 may be a result of greater operational experience, as well as more reliance on satellite data in Best Track determinations. This is certainly true when the satellite is the only available reconnaissance platform.

TABLE 2-2. POSITION CODE NUMBERS

PCN	METHOD OF CENTER DETERMINATION/GRIDDING
1	EYE/GEOGRAPHY
2	EYE/EPHEMERIS
3	WELL DEFINED CC/GEOGRAPHY
4	WELL DEFINED CC/EPHEMERIS
5	POORLY DEFINED CC/GEOGRAPHY
6	POORLY DEFINED CC/EPHERMERIS

CC=Circulation Center

TABLE 2-3. Mean Deviations (nm) of DMSP Derived Tropical Cyclone Positions from JTWC Best Track Positions, 1973-1975 (all sites). Number of cases shown in parentheses.

PCN	1973 (GUAM)	1974 (ALL SITES)	1975 (ALL SITES)
1	15.5(129)	13.6(224)	11.8(214)
2	20.0(17)	17.4(37)	20.4(35)
3	20.3(252)	20.1(422)	21.2(271)
4	20.0(24)	23.9(70)	22.4 (50)
5	45.9(163)	35.4(342)	34.2(323)
6	29.6(20)	49.4(108)	44.7(71)
1&2	16.0(146)	14.2(261)	13.0(249)
3&4	20.3(276)	20.6(492)	21.4(321)
5&6	44.1(183)	38.8(450)	36.1(394)
TOTAL	26.4(605) (23 storms)	26.0(1203) (35 storms)	25.2(964) (25 storms)

The most significant problem in DMSP reconnaissance support to JTWC is the availability and timeliness of spacecraft. To satisfy the JTWC requirement, DMSP data must be available within a specified time frame. The variable warning time allows for some warning time flexibility so satellite reconnaissance inputs can be maximized, but near real time DMSP inputs continue to be essential. Decreased direct-readout coverage in WESTPAC is reflected by the drop in the DMSP use rate for warnings from 43.8% in 1974 to 36.4% in 1975. The critical impact of direct readout capabilities on the viability of the DMSP support to JTWC is obvious. The future of DMSP reconnaissance will be heavily dependent upon the successful exploitation of the new generation (5D) DMSP spacecraft in mid-1976.

6. RADAR RECONNAISSANCE SUMMARY

During the 1975 typhoon season 446 radar center fixes were received at JTWC; 444 from land stations and 2 from WC-130 aircraft of the 54WRS. This number is less than one-half the number received during the 1974 season (997). The decrease is primarily due to the speed of movement of the systems. Although the number of storms within radar acquisition was similar in 1974 and 1975 (16 and 14 respectively), the speed of the 1975 storms was nearly twice that of those of the previous year. Of the 14 tropical storms and typhoons that came under radar surveillance, seven, Mamie, Nina, Ora, Phyllis, Rita, Betty and Cora, had tracks within range of Japan and/or the Ryukyu Islands, where the Japanese Meteorological Agency has established an extensive and highly reliable radar network. These seven tropical cyclones accounted for 78% of all radar reports. Surprisingly, this is the identical percentage of reports produced by the seven storms that traversed the Japan-Ryukyu region during 1974. Typhoon Rita, which meandered from the southern Ryukus to northern Japan, accounted for 104 reports or 23% of the 1975 total. Four storms, Nina, Ora, Phyllis and Rita, were at some time under the surveillance of four different radar sites. Rita was tracked by eight separate radar stations during her life.

Most radar reports are placed into three categories of accuracy defined in the WMO radar code. The categories are: good {within 10 km (5.4 nm)}, fair {within 10-30 km (5.4-16.2 nm)} and poor {within 30-50 km (16.2-27 nm)}. Of the 389 reports coded in this manner, 48% were good, 6% were fair and 46% were poor. Radar reports made only while storms were of typhoon intensity had 47% in the good category. All radar reports were compared to the JTWC best track and the mean vector deviation was 10.1 nm, the smallest deviation since the 1970 season. The two aircraft radar fixes deviated 16.1 nm from the JTWC best track.

Of the 444 radar reports, 78% were obtained from sites in the Japan-Ryukyu network, 14% from Taiwan, 4% from the Philippines, 3% from the Royal Observatory at Hong Kong and 1% from Guam. Radars of National Meteorological Agencies accounted for an impressive 90% of all reports while AC&W and U. S. Air Force Weather Service units accounted for 5% each.

During the 1975 season 17 warnings (4.1%) were based on radar.

7. COMMUNICATIONS

JTWC receives its data and disseminates its warnings through a variety of communication systems, including AUTOVON, AUTODIN, the Naval Environmental Data Network (NEDN), and the Air Force's Automated Weather Network (AWN). Much of the basic meteorological intelligence is received via the NEDN and graphically displayed by

FWC computers. More timely observations, tailored bulletins, and reports are received by JTWC on a dedicated AWN circuit directly from the AWN switch at Clark AB. Autodin is used for dissemination of warnings which are subsequently also transmitted on the AWN. Some more unique communication procedures are discussed below.

a. AIR TO GROUND

Aircraft reconnaissance data are normally received by JTWC via direct phone patch through the Andersen Aeronautical Station, which is the primary station for this purpose. Under degraded radio propagation conditions, the Clark or Yokota Aeronautical Stations can intercept and relay the data via AUTOVON and teletype to JTWC.

The preliminary eye/center data message contains sufficient information to permit JTWC to begin early preparation of individual warnings. Average communication delays for the preliminary and the complete eye/center data messages were 21 and 49 minutes, respectively in 1975. In the past three years, they have stabilized near 19 and 48 minutes, respectively. Delay times are defined as the difference between the fix time and the time of message receipt at JTWC. Table 2-4 depicts the complete eye/center data messages received more than 1 hr after fix time and after warning time.

TABLE 2-4. 1975 AIR/GROUND DELAY STATISTICS FOR AIRCRAFT RECONNAISSANCE

	1971	1972	1973	1974	1975
%Complete fix messages delayed over one hour	6	6	20	19	20
%Complete fix messages received after warning time	2.1	5.5	10.1	4.9	3.7

b. SELECTIVE RECONNAISSANCE PROGRAM

With the advent of the SRP, the importance of radar and satellite fix data has continued to increase. Data from the AC&W radar sites in the Republic of the Philippines and from nationally operated radars of the Republic of China, Hong Kong, Japan, and the Philippines are recieved at JTWC by means of the AWN.

Over 1000 position and intensity estimates were derived from Air Weather Service (AWS) DMSP sites and the Air Force Global Weather Central during 1975. The data from the AWS DMSP sites were immediatley passed via AUTOVON followed by an AWN message. AUTOVON provided rapid communication of the essentials and a brief two-way discussion of the data (a benefit not possible by message).

c. OUTGOING COMMUNICATIONS

Messages originating at JTWC are processed by the Naval Telecommunications Center (NTCC) of the Naval Communications Station, Guam. By special agreement, all tropical cyclone warnings are placed in the communications system before pending IMMEDIATE precedence traffic. In 1975, warnings were delivered to the message center an average of 25 minutes before warning time with an average handling time of 8 minutes. The time of receipt of a warning at a particular station depends upon factors beyond the control of either JTWC or NTCC.